

Technological Efforts & Internationalization of IT firms in India

K. Narayanan & Savita Bhat

This paper examines the role of technological efforts, both internal (in-house R&D) and external (technology imports), in determining inter-firm variations in internationalization. The study, using the resource-based perspective, finds that there are differences in the determinants of exports and overseas investments. Also, the effects of the technological factors differ between a software and services firm and a hardware firm. The study finds support to the view that, presently, IT firms in India are gaining competitive advantage over their rivals by exploiting the technological gap along with factor cost differentials. The paper suggests that the firms need to create niche markets to have long-run competitive advantage in the international market.

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Developing Country Perspective

Recently, World Trade Report noted that, in the year 2005, world merchandise export was around \$10121 billion and world commercial services export was around \$2415 billion (WTO 2006). In the same year, the value of India's merchandise and commercial services exports stood at \$90 billion and \$68 billion respectively. In the year 2005, approximately 17 percent of the world foreign direct investment (FDI) came from developing countries (UNCTAD 2006). In the case of India, the outward FDI stock as a percentage of Gross Domestic Product (GDP) increased from 0.4 percent in 2000 to 1.2 in 2005.

From the point of view of developed countries, there are numerous theories and empirical studies on international trade, and existence and growth of Multinational Companies (MNCs), (e.g. Posner 1961, Hufbauer 1966, Vernon 1966, Krugman 1979, Lall 1980, Pavitt & Soete 1980, Buckley & Casson 1985, Fagerberg 1988, Grossman & Helpman 1991, Balestra & Negassi 1992, Dunning 1993, Wakelin 1998, Co 2001). From the developing country perspective, the literature on

internationalization is dominated by studies on export competitiveness of the developing country firms (e.g. Kumar & Siddharthan 1994, Siddharthan & Nollen 2004, Narayanan 2006, 2007) and effect of inward Foreign Direct Investments (FDI) on these economies (Kumar 1994, Siddharthan & Rajan 2002).

The Information Technology (IT) sector of India, in particular, has been growing at an annual average growth rate of more than 25 percent over the past few years (Statistical Year Book 2005-06). The IT sector exports a substantial portion of its turnover. Lately, many of the firms in this sector have been observed to be choosing the FDI mode of internationalization. The present study attempts to understand the determinants of internationalisation of IT firms in India, captured in terms of exports and overseas investments. It is proposed that inter-firm differences in ownership specific advantages (O) in the home country would lead to differential international competitiveness of the firms. Specifically, we examine how O-advantages generated through differential technological efforts affect exports and overseas investments. The technological efforts are in the form of in-house Research and Development (R&D), embodied technology through import of capital goods and raw materials and spares, and import of disembodied technology against royalty and technical fee payments. An unbalanced sample drawn from the IT industry in India is empirically analyzed using maximum likelihood based Tobit estimation technique.

Overview of India's IT Sector

IT production and exports have been showing increasing trend over the past few years (Narayanan & Bhat 2009). During the year 2005-06, IT production in India was estimated at US\$ 42.34 billion, approximately 6 percent of India's Gross Domestic Product (GDP) and 2 percent of world IT production (Statistical Year Book 2005-06). Software and services accounted for around 67 percent of this production and the rest were from the electronics hardware sub-sector. Over the years, the gap between the production of software/services and electronics hardware sub-sector is also increasing (*Ibid*). In the year 2005-06, approximately US\$ 25.89 billion (61 percent) of Indian IT products and services were exported. Today, Indian IT firms have entered both offshore and on-site businesses. However, most of the IT products and services still consist of routine support, maintenance, coding, and semi-developed package production projects (Heeks 1998, Radhakrishnan 2006). Of late, many of the IT firms have been seen investing on offices, development centres, subsidiaries, and joint ventures overseas. These investments have been mainly in the developed countries such as the USA and UK (Pradhan 2007), which are also the major destinations of IT exports. It is believed that the IT multinational companies (MNCs) from India are using market seeking and efficiency seeking FDI to come closer to their prospective clients in these countries (UNCTAD 2006, Henley 2006-7). Table 1 summarizes some of the

strategies that are being used by the IT firms in India to achieve global competitiveness. The nature of knowledge flows involved in implementation

of these strategies is also indicated. Often, IT firms adopt more than one of these strategies to internationalize.

Table 1: Some Strategies for Global Competitiveness & Nature of Knowledge Flows

Sl.	Some Strategies to Achieve Global Competitiveness by IT Firms in India	Nature of Knowledge Flows Involved
1.	Acquisition of ISO, CMMI, and other certificates to assure better quality, lower delivery time, lower costs, and safety of intellectual properties of the suppliers and clients.	<ul style="list-style-type: none"> • Regular technology imports and in-house efforts to ensure quality. • Regular interactions with the suppliers and customers and assimilation of better technological and managerial processes. • Skill improvement of the employees to follow the globally accepted procedures.
2.	Production of proprietary products and services.	<ul style="list-style-type: none"> • Continuous tracking of the latest technological developments in the relevant field. • Continuous in-house efforts and skill development to produce proprietary products and services.
3.	Focus on specific domain of expertise.	<ul style="list-style-type: none"> • Concentrated efforts to gather information and become competitive in the specific domain. • Knowledge regarding other domains passed on to either group subsidiaries or to other companies that are willing to take over.
4.	Diversification into several domains of expertise.	<ul style="list-style-type: none"> • Regular in-house efforts to enhance knowledge and skills in different domains. • Import of technology related to the new area.
5.	Formation of Strategic Alliances with other firms and research institutes.	Mutual exchange of knowledge between the strategic alliance partners regarding technology and markets.
6.	Acquisition of the company by an overseas company or subsidiary of a foreign firm.	Mutual exchange, assimilation, and enhancement of the technological skills, products and services in the acquired and acquiring companies.
7.	Overseas establishment of new subsidiaries or overseas acquisition of existing firms.	Mutual exchange, assimilation, and enhancement of the technological skills, products and services in the acquired and acquiring companies.

Source: Based on of Technology and Managements Notes available in CMIE PROWESS database for some of the years for some firms included in the analysis.

The top IT companies in India such as Wipro and Infosys Technologies have Software Engineering Institute Capability Maturity Model (SEI-CMM) Level 5 certification for their operations.

Many IT firms try to acquire certificates to assure better quality, lower delivery time, lower costs, and safety of intellectual properties of the suppliers and clients.¹ The top IT companies in India such as Wipro and Infosys Technologies have Software Engineering Institute Capability Maturity Model (SEI-CMM) Level 5 certification for their operations. Also, in the year 2006, Tata Consultancy Services became the first organization in the world to be certified enterprise-wide for International Organization for Standardization's ISO 9001:2000, British Standards Institution's BS 7799-2:2002 and BS 15000-1:2002. According to the latest report by IBEF (2008), India is almost the top country in hosting ISO certified firms. Furthermore, 55 percent of the world SEI-CMM Level 5 firms are also present in India. However, for

acquiring and maintaining these certifications, the firms have to ensure regular resource allocation towards knowledge development.

Other IT firms choose to become globally competitive by producing proprietary products and services by means of their dedicated R&D efforts. For example, the IT firm Subex provides revenue maximization solutions to communications service providers worldwide through its trademark products and services such as Ranger™ (a fraud management system) and Incharge™ (a revenue assurance system). Similarly, SQL Star International has developed EMBINUX a complete Embedded Linux platform specifically designed and optimized for Wireless Handsets, Mobile Phones and Smart Consumer Electronics Devices. Another firm, Infosys Technologies has its own registered products and services like Finacle (a banking product suite) and InFlux™ (requirements and performance modeling tool). The firm regularly invests on in-house R&D to improvise over these products and services.

¹ The Carnegie Mellon Software Engineering Institute (SEI) defines, in the form of different levels of Capability Maturity Model (CMM) or Capability Maturity Model Integration (CMMI), specific management practices that need to be followed in the process of production of software. The IT firms that conform to these practices can then be awarded the CMM or CMMI certificate. Similarly, there are other organizations like the International Organization for Standardization and British Standards Institution that confer quality certifications to the firms that follow

certain procedural guidelines while producing products and services in general. For example International Organization for Standardization's ISO 9001:2000 is specifically for quality management procedures, British Standards Institution's BS 7799-2:2002 is for information security management procedure and British Standards Institution's BS 15000-1:2002 is for IT service management. Relevant website links for SEI-CMM is www.sei.cmu.edu/cmm, for ISO is <http://www.iso.org/iso/home.htm> and for BS is <http://www.bsi-global.com/>

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Even if the firms are not able to produce their branded products and services, they may choose to concentrate on a specific domain to provide efficient products and services. For example, Aurionpro Solutions and Polaris Software Lab are focusing on only Banking, Financial Service and Insurance (BFSI) segment. Still other firms may even hive off their diversified portfolios to concentrate on specific domain. For example, to focus on Airline vertical, Kale Consultants detached from its various other businesses and acquired Cognosys Software, a travel technology company, to facilitate its foray into the travel and transport vertical. With this restructuring, Kale has emerged as a focused solution and outsourced services provider to airlines and travel industry. The company sold its banking products Division to Onward Technologies. The software business from Citibank/OrbiTech was divested to Polaris Software while the generic software services business was hived off to an independently managed subsidiary Synetarios Technologies. Such firms that are dependent on a specific domain for their operations would have to acquire in-depth understanding of the domain.

Alternatively, firms can try to diversify their portfolio to add more

clients. For example, Quintegra Solutions focuses on delivering an integrated set of IT services in industries like financial services, manufacturing, education, healthcare and hi-technology. Similarly, HCL Technologies, one of India's leading global IT services companies, delivers solutions across different verticals including financial services, retail & consumer, life sciences & healthcare, hi-tech & manufacturing, telecom and media & entertainment. Again, Mascon Global, a foreign owned global information technology services company with its principal delivery and development centres in India, offers services in multiple industry verticals including manufacturing, financial services, retail, telecommunications and healthcare. To successfully operate in diversified areas, the firms would have to continuously put in efforts to enhance their knowledge base.

Frequently, firms form strategic partnerships with overseas firms and institutions to sell their products and services. 3i Infotech, using a partnership sales strategy, has been able to sell its products and services in more than 40 countries. Firstsource Solutions has entered into a strategic partnership with Metavante to penetrate North America banking market. Mastek has signed a strategic partnership agreement with Euriware of France to win clients in France. Sometimes, such partnerships with other firms and research institutes are formed to jointly develop new products and services. For example, Tata Consultancy Services has strong innovation network that includes clients,

other industry leaders, business partners, and university partnerships along with its internal R&D centres. It has been able to file several patents in India as well as overseas. Similarly, the Software Engineering and Technology Labs (SETLabs) of Infosys Technologies has collaborated with the Indian Statistical Institute to work out alternate pricing model that has been filed for a patent. The Field Optimization Suite, jointly developed by Infosys Technologies Ltd. and British Telecom (BT), won the National Outsourcing Association (NOA) award for Innovative Out-sourcing Project of the Year 2007. Another company, Cranes Software Intl. in association with the Centre for Sponsored Schemes and Projects of Indian Institute of Science (IISc), Bangalore, has set up a MEMS (Micro-Electro-Mechanical Systems) design and test laboratory inside IISc. The IISc and Cranes Software Intl. Ltd would jointly own the Intellectual Property rights and patents for technologies and products developed by this Cranes Sci MEMS lab.

Today, India is a favourable destination for inward FDI. To tap the opportunities in India and overseas, many foreign firms are establishing their own subsidiaries in India or acquiring internationally oriented Indian companies. Many of these foreign owned firms make use of resources in India to serve foreign markets. For example, Flextronics Software Systems (formerly known as Hughes Software Systems Limited) is an end-to-end communication solutions provider, catering to over 200 customers worldwide in the

telecom infrastructure, service provider and business process outsourcing sectors. Hughes Network Systems Inc., USA and its subsidiaries promote the company. Similarly, Hewlett-Packard Globalsoft, is a subsidiary of Hewlett-Packard Company, that has been exporting services from India. Interestingly, Tech Mahindra was formed in 1987 as a joint venture between Mahindra and Mahindra and British Telecommunications plc. Similarly, IBM Daksh Business Process Services was formed after acquisition of India-based business process outsourcing firm Daksh eServices by global IT firm International Business Machines (IBM). Similarly, Mastek-D C Offshore Devp. Co. was a 100 percent export oriented joint venture (JV) between Mastek Ltd. and Deloitte Consulting LLP- a subsidiary of Deloitte & Touche USA LLP. The JV has now become a wholly owned subsidiary of Deloitte Consulting after Mastek sold all its equity to the affiliates of Deloitte Consulting. Due to their foreign affiliations, these firms are able to keep themselves updated about the latest developments in the world IT sector.

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Lately, developing country firms are also seen using the FDI mode to internationalize. In line with this trend, several IT and IT enabled service (ITES) firms in India are seen investing overseas either on acquisitions and/or on establishment of subsidiaries. To successfully

integrate the subsidiaries with the parents, mutual exchange of the technological skills and proprietary knowledge has to take place. Often, efforts are put in to assimilate and further develop the skills, products, and services. Although most of the IT firms make use of their overseas subsidiaries to market and sell their own products and services abroad, often, the acquiring firms get benefits (in terms of access to intellectual properties and market knowledge) of the acquired firms. For example, Aftex acquired Arexera (a Switzerland based conglomerate) to not only get into European market but also to acquire its IPRs. Similarly, Accel Frontline, an IT solution provider, acquired banking solutions division of Telesis Global Solutions to have access to the latter's software IPs. Sasken Communication Technologies too became the owner of a patent through acquisition of Botnia Hightech Oy, a Finland based company. MosChip (India) designs the product and the Application Specific Integrated Circuits (ASICs) either alone or jointly with its subsidiary in USA. The software is then licensed to MosChip USA, which subcontracts the manufacturing to ASIC Service Providers and sells the chip through its distribution network worldwide. Thus the whole of exports for this firm is only in the form of after sales services. In each of the above strategies, some amount of knowledge flow and/or knowledge development has been taking place.

Analytical Framework

At macroeconomic level, the proponents of technology gap theory

(Posner 1961) propose that technological differences between countries determine the direction of international trade. The new trade theorists too incorporate technological factor in their model to explain international trade (Grossman & Helpman 1991). Others like Vernon (1966) have used product cycle approach to explain both international investments and international trade. According to this approach, any new un-standardized product is first produced in the advanced country like USA where there is abundant resource for undertaking rigorous research. As the product matures and the market expands, it is exported from the producer country. Later, when the product is standardized, cost factors become more important. At this stage, the labour-intensive stages of production are carried out in the less-developed countries through foreign direct investments (Buckley & Casson 1985).²

The proponents of the evolutionary theoretical framework (Nelson & Winter 1982) suggest that there are inter-firm differences in capabilities of the firms that lead to differences in competitiveness of the firms and nations. Further, they propose that development of a firm is path

² Nowadays, firms from developing countries like India are also making global presence in high-tech industries such as IT and Pharmaceuticals. Hence, it may seem that Vernon's (1966) approach is not directly applicable to the present world scenario. However, most of the developing country firms operating in high-tech sectors are still operating at the lower end of the technology ladder where products and processes are nearly standardized.

dependent. In other words, a firm generally builds over its already existing resources and capabilities (trajectory shifts). However, over time, firms can accumulate substantial capabilities to have major shifts in their operations (paradigm shifts).

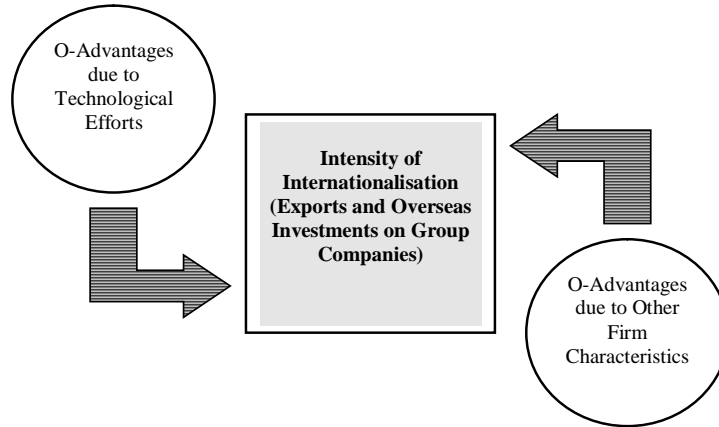
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The Resource-Based Perspective (RBP) of the strategic management literature borrows concepts from the evolutionary theoretical framework and the theory of industrial organization to propose that the heterogeneous resource endowments of the firms result in differences in competitiveness of the firms (Barney 1997, Peteraf 1997, Mahoney & Pandian 1997, Wernerfelt 1997). According to this perspective, to successfully compete in any market, a firm must possess some firm-specific tangible or intangible resource or asset that can create a barrier for others to enter the industry (Wernerfelt 1997). For sustained competitive advantage, these heterogeneous resources are not easy to imitate and substitute (Mahoney & Pandian 1997). Examples of such firm specific strategic resources include capital, production experience, brand loyalties, technological leads, and skills of the personnel.

Dunning's (1993) eclectic or Ownership-Location-Internalization (OLI) framework is a general theory of the MNCs that has been widely used by

researchers to explain existence and behaviour of MNCs. It suggests that firms locate to foreign countries due to the existence of ownership (O), location (L) and internalization (I) advantages. The ownership (O) advantages or core competencies of the firm are supposed to arise due to various firm specific factors including technological superiority of the firms. The firms can take advantage of these O-factors and production factors (L) in the host countries to compete overseas. The nature of internalization advantages (I) would determine the choices of entry mode for the MNCs.

The O-factors in Dunning's OLI framework are similar to the strategic resources in the Resource-Based Perspective. However, while the OLI framework focuses on host country perspective to examine FDI mode of internationalization, the RBP is a general theory that considers role of strategic resources in determining competitiveness of the firms. Since, this study takes a home country perspective to analyze the determinants of internationalization of firms with regard to both exports and overseas investments, an analytic framework (Fig.1) based on the relatively broader Resource-Based Perspective of the firm has been followed. In this framework, effect of O-advantages generated through both technology sourcing (such as in-house R&D, import of capital goods and technology) and other firm specific characteristics (such as size of the firm, age of the firm, affiliation of the firm) on internationalization have been considered.

Fig. 1: The Analytical Framework

Siddharthan and Nollen (2004) and Narayanan (2007) have investigated the effect of technological efforts on export competitiveness of the IT firms in India. Kumar (1982) and Lall (1982) have looked into the emergence of third world multinationals in general and Pradhan (2004) and Narayanan and Bhat (2009) have specifically studied MNCs of Indian origin. The present study analyzes the determinants of both exports and overseas investments mode of internationalization using a more recent sample from the IT industry in India.

Sample & Variables

An unbalanced sample of 2811 observations from the IT industry in India has been considered. The study period is of seven years (2001-2007). The source of the data is Prowess database provided by Centre for Monitoring Indian Economy (CMIE). The database contains data on both listed and un-listed companies from Indian

industries. As per Prowess database, the sample consists of mainly software firms, with only 44 hardware and 83 service providers. Around 67 firms entered the industry during the period of analysis.

Table 2 gives the definition of the variables used in the study. A firm may either choose to produce goods and services in India and export them to earn short-term gains or may choose to invest overseas on associate companies and subsidiaries to earn rewards in the long run. Thus, export intensity (EXPI) and intensity of overseas investment on group companies (OIGC) are the two variables denoting internationalization of the firms.

Regardless of the mode chosen for internationalization, the extent of internationalization would depend on the ownership specific assets that the firm possesses. Technology can be one such asset that can give definite competitive advantage to the firm over rivals

Table 2: Variables & their Definitions

Sl.	Variable	Symbol	Definition
1	Export Intensity	EXPI	Export of goods and services /sales*100
2	Intensity of Overseas Investment on Group Companies	OIGC	Overseas investments on group companies/ assets*100
3	R&D Intensity	RDI	R&D investments/sales*100
4	Import of Capital Goods Intensity	MKI	Expenditure on import of capital goods/ sales*100
5	Import of Design, Drawings, and Blueprints Intensity	MTI	Forex expenditure of royalty and technical fees/sales*100
6	Import of Raw Material and Spares Intensity	MRSI	Expenditure on import of raw material and spares/sales*100
7	Intensity of Outsourced Manufacturing and Professional jobs	OUTS	(Amount spent on outsourcing manufacturing jobs + software development fees + IT enabled services charges)/ sales*100
8	Size of the firm	SIZE	Sales turnover of the firm
9	Skill content of the firm	SKILL	Salary and wages/sales*100
10	Experience of the firm	AGE	Year under study – Year of incorporation of the firm
11	Hardware firm	D_{hard}	$D_{hard} = 1$ if the firm is a hardware producer $D_{hard} = 0$ Otherwise
12	Affiliated firm	D_{aff}	$D_{aff} = 1$ if the firm is affiliated to a business house or foreign firm $D_{aff} = 0$ Otherwise

(Dunning 1993, 2000, Wernerfelt 1997). By means of in-house R&D efforts (RDI), firms can become proprietary owners of both product and process innovations (Pugel 1981). In India, however, R&D expenditure as a percentage of GDP in 2000 was only around 0.9 percent compared to 2.7 percent for US (WTO 2006). Further, in the same year the share of private sector R&D in the total R&D was only 23 percent. Nevertheless, the firms that do invest on R&D are more likely to be able to generate O-specific assets to venture into international markets.

Import of capital goods (MKI) and import of raw materials and spares (MRSI) would bring with them latest technology embodied within the machinery and components.

The developing country firms are generally believed to be propagators of the innovations originating in the developed countries. Hence, the firms can gain O-specific advantages at home through technology imports. Import of capital goods (MKI) and import of raw materials and spares (MRSI) would bring with them latest technology embodied

within the machinery and components. With the help of this modern technology, the firm would be able to cater to the needs of the global market more efficiently. This is especially true for the IT industry, where technology changes very rapidly. Import of designs, drawings, and blueprints against royalty payments (MTI) also brings with it technological knowledge that can be used to produce products and services of world standards. Firms may augment these imported technologies with in-house efforts to assimilate the existing technology and then improve it to produce proprietary technological assets (Kumar 1982). Sometimes, even if the imported technology is not enhanced, the developing country firms can become MNCs by taking advantage of low technology-transfer and managerial costs in their home countries (Lall 1982). In case of IT industry, the technology-transfer costs can be still lower since much of the intra-firm transfer of codified knowledge can take place over Internet.

Information Technology firms sometimes outsource part of their manufacturing jobs to outsiders (OUTS). These jobs are generally routine maintenance jobs. Through outsourcing, the firms can increase their competitiveness by concentrating more on innovative activities. Size of the firm (SIZE), skill content of the work force (SKILL) and experience of the firm (AGE) are some other firm characteristics that can also give O-advantages to the firm. For example, large size of the firm would indicate the availability of sufficient resources to invest on foreign client search and subsidiary

establishment (Pugel 1981, Kumar 1982). In the case of IT industry where replication of products and services is easy, the firms can operate at large scale and achieve cost advantages. Similarly, higher investments by a firm on wages and salaries would indicate higher skill content in the firm (SKILL). The technical, managerial, and marketing skills of the workforce can be used in product differentiation and efficient production (Lall 1982). In case of IT industry, the technique of body shopping or on-site production can be exploited by the overseas subsidiaries of the firms as well. Again, older firms would have accumulated capabilities and experiences over the years of their existence. This can give them confidence to venture into uncertain overseas markets.

The government of India has been giving various incentives to the software and services sector to internationalize. Hence, the hardware firms (D_{hard}) might be at a disadvantage when compared to software and services firms in terms of international competitiveness. Again, a firm affiliated to a foreign firm or a business house (D_{aff}) would be able to take advantage of the brand name, contacts, resources, and experience of the parent firm to have competitive edge over its rivals in overseas market.³

3 Affiliation status of a firm is decided based on the information provided by Prowess database on ownership group of the firm. Prowess claims that it classifies a firm under a group it is most closely associated with based on continuous monitoring of the firm's announcements and a qualitative behaviour of the group-wise behaviour of individual firms. It also gives a separate field with information regarding the overseas investments of the firm on group companies.

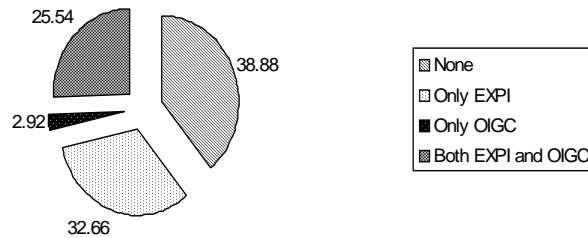
Khanna and Yafeh (2007) studied the reasons behind formation of different business groups in emerging markets. According to them business groups are a set of legally independent firms that generally operate in unrelated industries and are together due

to formal links, like equity, or informal links, like family. They proposed taxonomy for business groups along three dimensions, namely, group structure, group ownership and control, and group interaction with society. In India, most of the family owned businesses emerged during the protected regime in 1960s and 1970s, some others were formed after transfer of assets from British to Indians during Independence, and still other clusters of business groups have originated due to ethnic, religious, and social similarities. Khanna and Yafeh (2007), however, note that there is lack of evidence in literature on the behaviour of family controlled groups. Also, very few studies have attempted to relate groups to monopoly power and imperfect competition.

Preliminary Analysis & the Model

As is clear from Fig. 2, nearly 60 percent of the observations in the sample are internationally oriented. More than half the sample ($32.66 + 25.54 = 57.98$ percent) uses export mode of internationalization and nearly a quarter

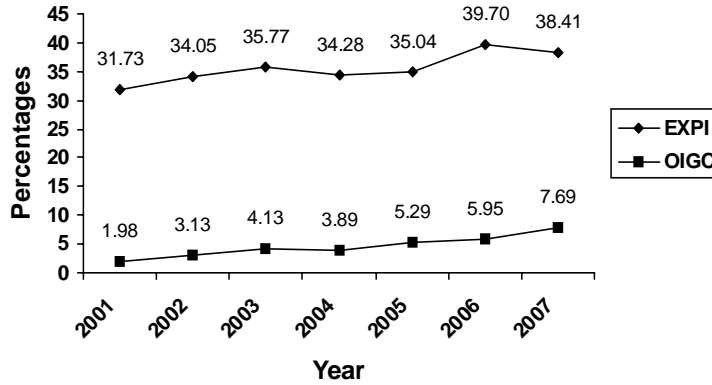
Fig. 2: Distribution of Exporters & Overseas Investors
Percentage Shares of Exporters and Overseas Investors



of them ($25.54 + 2.92 = 28.46$ percent) is investing overseas on group companies. However, most of the foreign investors are also exporters.

Over the period of analysis the average intensities of exports and overseas investments on group companies have shown a gradual upward trend (Fig. 3). While the average export intensity for the IT sample as a whole has been around 35 percent, there is a statistically significant difference in the average export intensity of hardware firms and others (Table 3). Compared to software and services firms, the average overseas investment on group companies is also lower for the hardware firms. However, on an average, the hardware firms in the sample have higher technology import intensities than the software and services firms. In this sample the software firms are generally smaller and younger (Table 3), however, they are more R&D intensive, better endowed with respect to skill content, and are more into outsourcing compared to the hardware firms.

Fig. 3: Trend in Average EXPI & Average OIGC
Trend in Average EXPI and OIGC



As is clear from Table 4, import of capital goods is the most popular mode (772 observations) of technology sourcing in this industry. On an average, within the R&D doing observations, software and services firms have higher R&D intensity compared to hardware firms. Furthermore, this difference

in the mean R&D intensity exists even when the sample is divided into only R&D undertaking firms and R&D with other technological activities (Table 5). This can imply that, on an average,

compared to hardware firms, the software and services firms are undertaking relatively more of innovative as well as adaptive R&D.

Table 3: Mean with Variance in Parenthesis

Sl.	Variables	Full Sample	Hardware Firms	Others (Software and Services Firms)
1	EXPI	35.49 (1737.00)	8.54 (443.78) ^c	37.71 (1778.98)
2	OIGC	4.51 (149.16)	0.49 (3.41) ^c	4.84 (159.73)
3	RDI	0.39 (6.51)	0.14 (0.21) ^c	0.41 (7.02)
4	MKI	1.71 (47.71)	2.13 (121.66)	1.68 (41.65)
5	MTI	0.28 (8.38)	2.20 (76.95) ^c	0.12 (2.43)
6	MRSI	1.16 (36.57)	10.57 (274.06) ^c	0.38 (9.20)
7	OUTS	1.49 (75.70)	0.56 (30.30) ^c	1.57 (79.37)
8	SIZE	118.51 (477724)	166.84 (139015.9) ^c	114.53 (505490.4)
9	SKILL	38.54 (8947.14)	9.74 (367.91) ^c	40.91 (9580.50)
10	AGE	10.95 (50.58)	14.58 (54.84) ^c	10.65 (49.07)
Number of Observations		2811	214	2597

^c The mean value of the firm characteristic is different at statistical significance of 10 percent level for Hardware and Others (Software and Services firms)

Table 4: Mean Values of the Technological Variables for the Sample[†]

Sl.	Technological Behaviour	Total	Hardware	Others (Software and Services Firms)
1.	RDI ^a	4.9 (221)	0.84 (35)	5.67 (186)
2.	MKI	6.24 (772)	8.4 (54)	6.08 (718)
3.	MTI ^b	7.05 (112)	12.09 (39)	4.36 (73)
4.	MRSI ^a	14.79 (220)	23.56 (96)	8.01 (124)

[†] Number of observations out of the total of 2811 undertaking the technological activity in parenthesis

^a Difference between mean RDI and MRSI for the hardware and others is statistically significant at 1 percent level

^b Difference between mean MTI for the hardware and others is statistically significant at 5 percent level

The technologically active hardware firms are investing relatively more on import of designs, drawings, blueprints, raw materials and spares

However, the technologically active hardware firms are investing relatively more on import of designs, drawings, blueprints, raw materials and spares (Table 4). A very high number of technologically active software and services observations (718) have opted for import of capital goods.

Table 5: Comparison of Mean Values of RDI for the Technologically Active IT Hardware & Other Firms in the Sample[†]

Sl.	Technological Activity	Hardware	Others ^b (Software and Services Firms)
1.	Only R&D ^a	0.61 (2)	7.99 (50)
2.	R&D with Technology Imports ^a	0.85 (33)	4.81 (136)

[†] Number of observations in parenthesis

^a Difference between mean RDI for the hardware and others subgroups is statistically significant at 1 percent level

^b Difference between the mean RDI for Only R&D and R&D with Technology Imports group is statistically significant at 5 percent level

The present sample contains both exporters and non-exporters and foreign investors and non-investors. For such a sample, where the dependent variable takes a zero value for many observations, models that use maximum likelihood estimation technique are considered to be more appropriate than ordinary least square (OLS) estimation technique (Greene 2002, Gujarati 2003,

Siddharthan & Nollen 2004, Narayanan 2006).

In India, Tobit model has been used for censored data (Kumar & Siddharthan 1994, Siddharthan & Nollen 2004, Narayanan 2006). According to these studies the advantage of using Tobit model instead of a Probit model is that information on the continuous values of explained variable is

not lost in Tobit models, whereas after converting the variable into binary form (as is the case in Probit model) valuable information is lost. Statistically, a general Tobit model can be expressed as:

$$\begin{aligned} Y_i^* &= \alpha_0 + \alpha_1 X_{li} + \dots + \alpha_n X_{ni} + u_i, \\ Y_i &= 0 \quad \text{if } Y_i^* = c, \\ &= Y_i^* \quad \text{if } Y_i^* > c \end{aligned} \quad \text{---(1)}$$

where subscript i stands for the particular observation, Y_i^* is the unobserved regressand or the latent variable (also called as index variable), c is the lower censoring limit, Y_i is the actual observed variable, and X_{li} to X_{ni} are the n regressors.

The Tobit models for EXPI and OIGC as explained variables is defined as follows:⁴

$$\begin{aligned} EXPI^* &= \alpha_0 + \alpha_1 RDI + \alpha_2 MKI + \alpha_3 MTI + \alpha_4 MRSI + \alpha_5 OUTS + \alpha_6 \\ &\ln SIZE + \alpha_7 \ln SKILL + \alpha_8 AGE + \alpha_9 D_{hard} + \alpha_{10} D_{aff} + \alpha_{11} RDI * D_{hard} \\ &+ \alpha_{12} MKI * D_{hard} + \alpha_{13} MTI * D_{hard} + \alpha_{14} MRSI * D_{hard} + u_1 \\ EXPI &= 0 \quad \text{if } EXPI^* = 0 \\ &= EXPI^* \quad \text{if } EXPI^* > 0 \end{aligned} \quad \text{---(2)}$$

where $EXPI^*$ is the latent (index) variable and EXPI is the corresponding observed export intensity.

$$\begin{aligned} OIGC^* &= \beta_0 + \beta_1 RDI + \beta_2 MKI + \beta_3 MTI + \beta_4 MRSI + \beta_5 OUTS + \beta_6 \\ &\ln SIZE + \beta_7 \ln SKILL + \beta_8 AGE + \beta_9 D_{hard} + \beta_{10} D_{aff} + \beta_{11} RDI * D_{hard} \\ &+ \beta_{12} MKI * D_{hard} + \beta_{13} MTI * D_{hard} + \beta_{14} MRSI * D_{hard} + u_2 \\ OIGC &= 0 \quad \text{if } OIGC^* = 0 \\ &= OIGC^* \quad \text{if } OIGC^* > 0 \end{aligned} \quad \text{---(3)}$$

where $OIGC^*$ is the latent (index) variable and OIGC is the corresponding observed overseas investment variable.

4 A critique of the estimated equations is that the variables EXPI and OIGC are simultaneously determined. One could use a simultaneous equation limited dependent variable regression like a simultaneous Tobit model for estimation. However, as we do not have access to any

statistical package that can solve simultaneous Tobit model, we use two separate Tobit models for analyzing internationalization in terms of exports and overseas investments on group companies.

Table 6: Correlation Matrix

	EXPI	OIGC	RDI	MKI	MTI	MRSI	OUTS	lnSIZE	lnSKILL	AGE
EXPI	1.00									
OIGC	0.28 ^a	1.00								
RDI	0.03	0.06 ^a	1.00							
MKI	0.26 ^a	0.01	0.001	1.00						
MTI	-0.03	-0.02	-0.01	0.0002	1.00					
MRSI	-0.05 ^a	-0.03	0.05	0.09 ^a	0.02	1.00				
OUTS	-0.06 ^a	0.01	-0.01	-0.03	-0.01	-0.03	1.00			
lnSIZE	0.39 ^a	0.18 ^a	0.10 ^a	0.12 ^a	0.06 ^a	0.21 ^a	-0.0002	1.00		
lnSKILL	0.29 ^a	0.12 ^a	0.02	0.06 ^a	-0.04	-0.13 ^a	0.11 ^a	-0.26 ^a	1.00	
AGE	-0.002	0.07 ^a	0.02	-0.03	0.04	0.14 ^a	-0.01	0.25 ^a	-0.13 ^a	1.00

^a indicates statistical significance at 1 percent level

The SIZE and SKILL variables have large variance (Table 3). Hence they have been introduced in the equations in logarithmic form to avoid heteroscedasticity problem (Gujarati 2003). Further, interactive variables ($RDI * D_{hard}$, $MKI * D_{hard}$, $MTI * D_{hard}$, and $MRSI * D_{hard}$) have been introduced to investigate the differences in the effects of technology variables on explained variables for the hardware firms and others (software and services). Among the technology variables, statistically, only MKI is positively correlated to EXPI and only RDI is positively correlated to OIGC (Table 6). SIZE and SKILL variables are positively correlated to both EXPI and OIGC. Overall, the value of all the correlation coefficients in the matrix is low suggesting that the multicollinearity problem is unlikely to arise in the present study.

Results & Discussion

Table 7 presents the maximum likelihood estimation results of the Tobit

models in equations 2 and 3. Since the χ^2 value is statistically significant, the estimated coefficients can be interpreted. On the whole, one can observe that there are differences in the effects of the explanatory variables on the two explained variables (EXPI and OIGC).

In line with other studies on international competitiveness of IT industry in India (Siddharthan & Nollen 2004, Narayanan 2007, Narayanan & Bhat 2009), technology-sourcing variables are turning out to be important in determining internationalization of firms. However, as was expected, there are differences between the software and services firms and the hardware firms with regard to the effects of technology variables on exports and overseas investments. While in-house R&D efforts are quite relevant for overseas investments in the case of the software and services firms, it is not so for the hardware firms. This implies that the software and services firms are able to

generate some ownership-specific assets through in-house R&D efforts that gives them confidence to invest overseas on subsidiaries and associate companies.

The software and services firms are able to generate some ownership-specific assets through in-house R&D efforts that gives them confidence to invest overseas on subsidiaries and associate companies.

Again, the software and services firms that are importing latest technology embodied in machinery are doing well in the export market. In

contrast, the software and services firms that are relying more on imported raw materials and spares for their older machinery are not doing that well in the export market. The firms that are importing latest capital goods are likely to be availing the Indian government's Export Promotion Capital Goods (EPCG) scheme. Nevertheless, the software and services firms that continuously import latest equipments and machinery would be able to provide their foreign clients with superior products and services compared to those firms that are either relying on older equipments or simply upgrading their old equipments by importing spares.

Table 7: Tobit Results for EXPI and OIGC as Explained Variables

Sl.	Explanatory Variables	EXPI as Explained Variable	OIGC as Explained Variable
1	Constant	-58.31 (-15.46) ^a	-51.65 (-17.79) ^a
2	RDI	-0.62 (-1.58)	0.42 (1.86) ^c
3	MKI	1.29 (8.60) ^a	-0.15 (-1.28)
4	MTI	-0.95 (-1.56)	-1.54 (-2.01) ^b
5	MRSI	-0.57 (-1.80) ^c	0.31 (1.69) ^c
6	OUTS	-0.25 (-1.85) ^c	0.12 (1.42)
7	lnSIZE	14.46 (27.96) ^a	5.02 (14.06) ^a
8	lnSKILL	18.44 (19.59) ^a	5.85 (9.05) ^a
9	AGE	-0.60 (-4.09) ^a	0.41 (4.37) ^a
10	D _{hard}	-49.80 (-8.59) ^a	-17.01 (-4.23) ^a
11	D _{aff}	1.37 (0.57)	3.63 (2.27) ^b
12	RDI* D _{hard}	7.07 (0.90)	2.15 (0.41)
13	MKI* D _{hard}	-0.201 (-0.58)	0.42 (1.99) ^b
14	MTI* D _{hard}	1.72 (2.31) ^b	2.10 (2.60) ^a
15	MRSI* D _{hard}	1.08 (2.72) ^a	-0.37 (-1.43)
	Number of Observations	2811	2811
	Log-Likelihood	-9337.35	-4489.63
	LR Chi ²	1464.23 ^a	545.82 ^a

^a, ^b, ^c indicate statistical significance at 1 percent, 5 percent, and 10 percent levels
Values in parenthesis are t-values

At the same time, the software and services firms that are importing more of raw materials and spares are doing well

in foreign investment market. This could be because, while the capital good importers are forced to concentrate more

on export market (due to export obligation under EPCG scheme), the firms that upgrade their old machinery and equipments through imports of spares can still have a competitive edge over other players (who are not even upgrading their old equipments) in the domestic market. This success in the domestic market might be giving the importers of raw material and spares the required funds and confidence to choose overseas investment mode of internationalization. However, the software and services firms that presently import a lot of designs, drawings, and blueprints, might require more in-house efforts to successfully assimilate the imported technology and to generate O-factors to successfully internationalize.

In the case of hardware firms, import of designs, drawings, and blueprints and import of raw materials and spares is turning out to be relatively more important for their export competitiveness.

In the case of hardware firms, import of designs, drawings, and blueprints and import of raw materials and spares is turning out to be relatively more important for their export competitiveness. Again, as compared to the software firms, embodied technology imports in the form of capital goods, designs, drawings, and blueprints also seem to be more relevant for overseas investments of hardware firms. It is quite possible that, as India lacks capabilities in hardware sector, the imported designs, drawings, blueprints, raw materials and

spares are based on the latest global computer hardware technology.

In the case of IT industry, the knowledge gained about the overseas market as a consequence of affiliation to business house and foreign firms is quite relevant for overseas investments. At the same time, other O-advantages acquired through vast resources available in the large firms and managerial and technical abilities available in the firms with large skill base are very important for both exports and foreign investments.

Unlike what was postulated, the firms that outsource a part of their production process are not able to do that well in the exports market. This could imply that the firms that lack technology or capabilities are the ones that are outsourcing portions of their work to others. Again, unlike what was hypothesized, experience of the firm doesn't seem to be that important to get into export market. This could be due to the fact that many new companies set up their units in the STPs, where it is mandatory to export. However, to have one's own foreign subsidiary, the firms do need to have some experience.

Summary & Conclusions

From the perspective of a developing country like India, the study analyzes how ownership specific advantages (O) at home, due to differential technological efforts or due to other firm specific characteristics, is important in determining inter-firm differences in the internationalization of the firms in the

IT industry in India. Both exports and FDI modes of internationalization have been considered. The study is based on the high-tech IT industry of India where firms can be seen to be using both the modes of internationalization. The analysis of unbalanced panel of 2811 observations for the past few years reveals the following points that are especially relevant to the IT sector in India:

1. From the home country perspective, a large number of IT sector firms in India are internationally oriented, either through exports or overseas investments. There seems to be a clear preference for exports mode of internationalization, since majority of the overseas investors are also exporting. It is possible that by forming overseas subsidiaries and taking advantage of the proximity to the foreign clients, the firms are able to capture larger and better projects. A more detailed study is required to probe this relationship between overseas investments and exports.
2. Technology sourcing variables such as R&D and import of technology emerge significant in determining international competitiveness of IT firms. Further, there are differences in the effect of these variables on exports and overseas investments. The effects of these variables also differ according to whether it is a software and services firm or a hardware firm. The government's scheme of Export Promotion Capital Goods (EPCG) seems to be quite effective in promoting exports in the software and services sector. At the same time O-advantages generated through in-house R&D efforts also seems to be effective for the software and services firms that would like to invest overseas on group companies. In the light of the fact that the software firms can easily import latest capital goods under the EPCG scheme, hardware firms have limited buyers in the domestic market. Furthermore, due to lack of capabilities in hardware technology, only those hardware producers in India that import latest technology are likely to be able to compete in both domestic and international markets. However, the O-advantages gained through imported technology can give a competitive edge to IT exporters only till the rivals also get hold of an equally competent technology.
3. The IT firms that have vast resources and skills have definite advantage in the international market. Hence, the smaller firms with limited resources can form networks with other small and large firms to overcome this advantage and capture larger projects overseas. The firms, both small and large, that lack appropriate skills, can also collaborate with research institutes to acquire knowledge about the latest IT technologies, enhance them, and produce proprietary products and services.
4. With encouragement from the government, IT firms are success-

fully getting into export market at a very early age. However, it appears that some amount of market experience is required before the firm can form subsidiaries overseas. Moreover, the resources and market knowledge gained by the affiliated firms from their parents is very important for the firms to invest overseas. The young firms can form consortiums with older, experienced, and business house or foreign firms to acquire knowledge about the policy environment and specific requirements of the clients in the overseas market. Using this knowledge, the young firms can quickly get into more specific, but contemporary, segment of IT production.

To develop international competitiveness, it is essential that the firms have O-specific advantages.

To develop international competitiveness, it is essential that the firms have O-specific advantages. In the case of India, imported technology and availability of resources are turning out to be important in determining internationalization of IT firms. Hence, it seems that, presently, most of the internationally oriented IT firms are gaining competitive advantage over their rivals (both domestic and overseas) by exploiting the technological gap along with factor cost differentials. However, such O-advantages would cease to exist once the rivals overcome the technological gap and the cost differentials are eroded.

In the long run, therefore, it is essential that Indian IT firms create niche markets for themselves. For this, the firms need to put in more efforts in searching for unexploited technological gaps in the IT sector. By forming networks and consortia in collaboration with other firms and research institutions and pooling the available knowledge about the latest technologies, the firms would be able to quickly discover new avenues in IT industry. The overseas subsidiaries can also act as technology snooping centres for this purpose. The Indian government can also play an affirmative role by acting as an intermediary in the technology search and assimilation processes.

References

- Balestra, P. & S. Negassi (1992), "A Random Coefficient Simultaneous Equation System with an Application to Direct Foreign Investment by French firms", *Empirical Economics*, 17: 205-20
- Barney, J.B. (1997), "Strategic Factor Markets: Expectations, Luck, and Business Strategy", in Foss, N.J. (ed.) *Resources, Firms, and Strategies*, Oxford University Press: 146-60.
- Buckley, P.J. & M. Casson (eds) (1985), *The Economic Theory of the Multinational Enterprise*, London, MacMillan.
- Co, C.Y. (2001), 'Trade, Foreign Direct Investment and Industry Performance', *International Journal of Industrial Organization*, 19: 163-83
- Dunning, J.H. (ed.) (1993), *United Nations Library on Transnational Corporations Vol. 1: The Theory of Transnational Corporations*, New York, Routledge.

- Dunning, J.H. (2000), "The Eclectic Paradigm as an Envelope for Economic and Business Theories of MNE Activity", *International Business Review*, 9:163-90.
- Fagerberg, J. (1988), "International Competitiveness", *Economic Journal*, 98: 355-74
- Greene, W.H. (2002), *Econometric Analysis*, Delhi, Pearson Education Asia.
- Grossman, G.M. & E. Helpman (1991), *Innovation and Growth in the Global Economy*, Mass, MIT Press.
- Gujarati, D.N. (2003), *Basic Econometrics*, fourth edition, New Delhi, MacGraw-Hill.
- Heeks, R. (1998), "The Uneven Profile of Indian Software Exports, Development Informatics", Development Informatics Working Paper Series Paper No. 3, accessed online October 1, 2007 from <http://unpan1.un.org/intradoc/groups/public/documents/NISPAcee/UNPAN015537.pdf>
- Henley, J. (2006-07), "Outsourcing the Provision of Software and IT-enabled Services to India: Emerging Strategies", *International Studies of Management and Organization*, 36 (4): 111-31.
- Hufbauer, G.C. (1966), *Synthetic Materials and the Theory of International Trade*, London, Gerald Duckworth
- IBEF (2008), *IT & ITES, India Brand Equity Foundation Report*
- Khanna, T. & Y. Yafeh (2007), "Business Groups in Emerging Markets: Paragons or Parasites?", *Journal of Economic Literature*, 45 (2): 331-72.
- Krugman, P. (1979), "A Model of Innovation, Technology Transfer and the World Distribution of Income", *Journal of Political Economy*, 87:253-66
- Kumar, K. (1982), "Third World Multinationals: a Growing Force in International Relations", *International Studies Quarterly*, 26 (3): 397-24.
- Kumar, N. (1994), *Multinational Enterprises and Industrial Organization: The Case of India*, New Delhi, Sage Publications.
- Kumar, N. & N.S. Siddharthan (1994), "Technology, Firm Size and Export Behaviour in Developing Countries: The Case of Indian Enterprises", *The Journal of Development Studies*, 31 (2): 289-309.
- Lall, S. (ed.) (1980), *The Multinational Corporation: Nine Essays*, London, The MacMillan Press Ltd.
- Lall, S. (1982), "The Emergence of Third World Multinationals: Indian Joint Ventures Overseas", *World Development*, 10 (2): 127-46.
- Mahoney, J.T. & J.R. Pandian (1997), "The Resource-Based View within the Conversation of Strategic Management", in Foss, N.J. (ed.) *Resources, Firms, and Strategies: A reader in the Resource-Based Perspective*, Oxford University Press: 204-31
- Narayanan, K. (2006), "Technology Acquisition and Export Competitiveness: Evidence from Indian Automobile Industry", in Tendulkar, S.D., Mitra, A., Narayanan, K., Das, D.K. (eds.), *India: Industrialization in a Reforming Economy*, New Delhi, Academic Foundation: 439-70.
- Narayanan, K. (2007), "Technology Acquisition and Competitiveness: Evidence from Indian IT industry", in Hashim, S.R. & Siddharthan, N.S. (eds.) *High Tech Industries, Employment, and Global Competitiveness*, New Delhi, Routledge.
- Narayanan, K. & S. Bhat (2009), "Technological Efforts and Export performance of IT MNCs from India", in Siddharthan, N.S. & K. Narayanan (eds.) *Indian and Chinese Enterprises: Global Trade, Technology and Investment Regimes*, New Delhi: Routledge [forthcoming].
- Nelson, R.R. & S.G. Winter (1982), *An Evolutionary Theory of Economic Change*, Cambridge: Belknap-Harvard.

- Pavitt, K. & L. Soete (1980), "Innovative Activities and Export Shares: Some Comparisons between Industries and Countries", in Pavitt, K. (ed.), *Technical Innovation and British Economic Performance*, London, The MacMillan Press Ltd: 38-66
- Peteraf, M.A. (1997), "The Cornerstones of Competitive Advantage: a Resource-based View", in Foss, N.J. (ed.), *Resources, Firms, and Strategies: A Reader in the Resource-Based Perspective*, Oxford University Press: 187-203
- Posner, M.V. (1961), "International Trade and Technical Change", *Oxford Economic Papers*, 13:11-37
- Pradhan, J.P. (2004), "The Determinants of Outward Foreign Direct Investment: a Firm-Level Analysis of Indian Manufacturing", *Oxford Development Studies*, 32 (4), 619-39.
- Pradhan, J.P. (2007), "National Innovation System and the Emergence of Indian Information and Software Technology Multinationals", Institute for Studies in Industrial Development Working Paper No. 2007/09.
- Pugel, T.A. (1981), "The Determinants of Foreign Direct Investment: an Analysis of US Manufacturing Industries", *Managerial and Decision Economics*, 2 (4): 220-28.
- Radhakrishnan, K.G. (2006), "India's Adolescent Software Industry", *Far Eastern Economic Review*, 169 (4): 34-39.
- Siddharthan, N.S. & S. Nollen (2004), "MNE Affiliation, Firm Size and Exports Revisited: A Study of Information Technology Firms in India", *The Journal of Development Studies*, 40 (6): 146-68.
- Siddharthan, N.S., & Y.S. Rajan (2002), *Global Business, Technology and Knowledge Sharing: Lessons for Developing Country Enterprises*, Delhi, MacMillan India Ltd.
- UNCTAD (2006), *World Investment Report 2006: FDI from Developing and Transition Economies: Implications for Development*, New York and Geneva, United Nations Conference on Trade and Development.
- Vernon, R. (1966), "International Investment and International Trade in the Product Life Cycle", *Quarterly Journal of Economics*, 80: 190-207.
- Wakelin, K. (1998), "Innovation and Export Behaviour at the Firm Level", *Research Policy*, 26:829-41
- Wernerfelt, B. (1997), "A Resource-Based View of the Firm", in Foss, N.J. (ed.) *Resources, Firms, and Strategies: A reader in the Resource-Based Perspective* Oxford: Oxford University Press: 117-30
- WTO (2006), *World Trade Report 2006: Exploring the Links between Subsidies, Trade and the WTO*, World Trade Organization.